Deaths in children and adolescents associated with COVID-19 and MIS-C in the United States

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Abstract

Objective—To describe the demographics, clinical characteristics, and hospital course among persons <21 years of age with a SARS-CoV-2-associated death.

Methods—We conducted a retrospective case series of suspected SARS-CoV-2-associated deaths in the United States in persons <21 years of age during February 12–July 31, 2020. All states and territories were invited to participate. We abstracted demographic and clinical data, including

laboratory and treatment details, from medical records and entered them into an electronic database.

Results—We included 112 SARS-CoV-2 associated deaths from 25 participating jurisdictions. The median age was 17 years (interquartile range 8.5–19 years). Most decedents were male (71, 63%), 31 (28%) were Black (non-Hispanic) persons, and 52 (46%) were Hispanic persons. Ninety-six decedents (86%) had at least one underlying condition; obesity (47/112, 42%), asthma (33/112, 29%), and developmental disorders (25/112, 22%) were most commonly documented. Among 69 hospitalized decedents, common complications included mechanical ventilation (45/60, 75%), acute respiratory failure (51/62, 82%), and acute renal failure (21/62, 34%). The sixteen (14%) decedents who met multisystem inflammatory syndrome in children (MIS-C) criteria were similar in age, gender, and race/ethnicity to decedents without MIS-C, and 11/16 (69%) had at least one underlying condition.

Conclusion—SARS-CoV-2-associated deaths among persons <21 years of age during February–July 2020 occurred predominantly among Black (non-Hispanic) and Hispanic persons, males, and older adolescents of all races/ethnicities. The most commonly reported underlying conditions were obesity, asthma, and developmental disorders. Decedents with COVID-19 disease were more likely than those with MIS-C to have underlying medical conditions.

Article Summary

We report the clinical characteristics and hospital course of persons <21 years of age with SARS-CoV-2-associated deaths in the United States during February–July, 2020.

Introduction

In previously healthy individuals <21 years of age, infection with SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19), is typically asymptomatic or mild, with recovery expected within 1–2 weeks.[1,2] An estimated 7% of children with COVID-19 are hospitalized[3], and 28–33% of hospitalized children require intensive care.[3–6] While individuals <21 years of age made up less than 2% of reported COVID-19 cases, as of April 13, 2021, more than 2.8 million cases and 377 deaths associated with SARS-CoV-2 in U.S. children <18 years were reported to the United States Centers for Disease Control and Prevention (CDC).[7]

Risk factors for death associated with COVID-19 among children are not well described.[8,9] In adults, risk factors include older age, male sex, and underlying medical conditions, including obesity, immunosuppression, chronic lung disease, cardiovascular disease, neurologic disorders, and diabetes.[10] In hospitalized children, the presence of underlying medical conditions increases the risk for severe illness from COVID-19.[4,11] In addition, children infected with SARS-CoV-2 can develop multi-system inflammatory syndrome (MIS-C), which predominantly affects previously healthy school-aged children.[12]

Given the low number of SARS-CoV-2–associated deaths among persons <21 years of age compared with adult deaths, limited information exists about the clinical course and underlying medical conditions among pediatric decedents. With the ongoing pandemic and increasing cases[13] and hospitalizations[14] in persons <21 years of age, we conducted an

expanded review of data from an earlier study[15] to describe the demographics, clinical characteristics, and complications seen in children and adolescents with SARS-CoV-2 who died in the United States during February 12–July 31, 2020.

Methods

Case definition:

We defined a SARS-CoV-2–associated pediatric death as a death occurring in a person <21 years of age with confirmed or probable COVID-19 and/or MIS-C and who died during February 12--July 31, 2020. The interim COVID-19 case definition published by the Council of State and Territorial Epidemiologists on August 5, 2020 was used to classify cases as confirmed or probable.[16] Briefly, a case was classified as confirmed COVID-19 if there was a documented positive SARS-CoV-2 molecular amplification detection test, and classified as probable COVID-19 if the decedent 1) met clinical criteria and had epidemiologic evidence without confirmatory laboratory testing; 2) met presumptive laboratory evidence and either clinical or epidemiologic criteria; or 3) met vital records criteria without confirmatory lab testing performed. Cases met MIS-C criteria if they fulfilled the case definition published in the CDC Health Alert Network Health Advisory on May 14, 2020.[17]

Case Ascertainment, Data Collection, and Data Entry:

State and local health departments report confirmed or probable COVID-19 cases[16] to CDC as an element of the integrated national pandemic response. We examined case-based data for persons <21 years of age with confirmed or probable COVID-19 and/or MIS-C who died during the study period. We contacted health departments in all 50 states, New York City, the District of Columbia, Puerto Rico, Guam, and the US Virgin Islands ($n = 55$) to review the identified deaths and to invite jurisdictions with at least one identified SARS-CoV-2-associated pediatric death to participate in this study (Figure 1). Classification of cases as SARS-CoV-2-associated deaths was determined by the individual jurisdictions.

Participating jurisdictions submitted demographic and clinical data on decedents abstracted from available medical records, death certificates, and autopsy reports. Clinical data included past medical history, presenting signs and symptoms, SARS-CoV-2 and other laboratory test results, clinical course and treatments received, location of death, and cause of death determination. Participating jurisdictions submitted information on all probable or confirmed SARS-CoV-2-associated deaths, as determined by the jurisdiction, in persons <21 years of age that occurred during the study period.

Information on decedents was collected and managed using REDCap (Research Electronic Data Capture)[18,19] hosted at CDC. Data were abstracted from available clinical charts and entered into a standardized REDCap form by either the participating jurisdictions (n=84) or CDC staff (n=28).

Ethical Approval:

This activity was reviewed by CDC and was conducted consistent with applicable federal laws and CDC policy.[20]

Inclusion Criteria:

> All cases of SARS-CoV-2-associated deaths in persons <21 years of age who died during the study period were considered for inclusion.

Exclusion Criteria:

> Decedents were excluded if the jurisdiction elected not to participate in the study (n=4); the clinical presentation, disease course, and pathologic findings after death were consistent with an etiology other than SARS-CoV-2 (n=2); or the decedents did not meet the confirmed or probable case definition (n=2; Figure 1).

Statistical Analysis:

> Continuous variables are expressed as median and interquartile ranges (IQR) and categorial data are expressed as counts and percentages. We did not impute missing data, and decedents with missing information on the variable of interest were excluded from any analyses of that variable of interest. The Mann-Whitney U test was used to compare age and illness duration, and the χ^2 test was used to compare all other variables. All statistical tests are two-sided and an α-value of 0.05 was considered significant. All statistical calculations were performed using SAS software Version 9.4 (SAS Institute, Cary, NC).

> Laboratory measurements were converted to one standard unit of measure. Age- and gender-specific ranges for normal values and tachycardia were determined using the Harriet Lane Handbook[21] and the Seattle Children's Hospital's Department of Laboratories online laboratory testing catalogue[22]. We used the age-specific obesity cutoffs from CDC's BMI-for-Age charts[23] and the World Health Organization's age-specific cutoffs for tachypnea.[24]

> Deaths that occurred at home or in the emergency department were classified as "non-hospitalized," and deaths that occurred after hospital admission were classified as "hospitalized."

Results

> Among the 55 jurisdictions invited to submit information, 47 responded. Twenty-five jurisdictions participated in the study, twenty jurisdictions reported no deaths, and two jurisdictions (representing 4 deaths) declined participation (Figure 1). We identified 112 deaths associated with COVID-19 and/or MIS-C in persons <21 years for inclusion in this study, of which 108 (96%) were confirmed and 4 (4%) were probable COVID-19 cases. Sixteen decedents (15%) met MIS-C criteria. The first death was reported the week of March 15, 2020 (Supplementary Figure 1).

> Most decedents were male (71/112, 63%, Table 1). The median age at death was 17 years (IQR 8.5–19, range 1 month to 20 years, Table 1). Race/ethnicity was reported for 111 decedents (99%). Of these, there were 52 (47%) Hispanic, 31 (28%) Black (non-Hispanic), 16 (14%) White (non-Hispanic), 5 (5%) American Indian or Alaska Native (non-Hispanic), 5 (5%) Asian/Pacific Islander (non-Hispanic), and 2 (2%) persons who identified as non-Hispanic of another race or of more than one race (Table 1). Decedents with MIS-C had similar age, gender, and race/ethnicity distributions as those without MIS-C (Table 2).

A death certificate was available for 74 (66%) decedents. COVID-19 was reported as the underlying cause of death in 48 (65%) and as a contributing factor in 21 (28%) decedents (Table 3). These decedents had similar age, sex, race/ethnicity, and underlying conditions as decedents without available information. The location of death was reported for 111 decedents (99%); 69 (62%) died in the hospital, 23 (21%) decedents died in the emergency department, 18 (16%) died at home, and one (1%) died in hospice care. Among decedents with MIS-C, 1/16 (6%) died at home or in the emergency department compared with 34/80 (43%) decedents without MIS-C (*p*=0.037).

Information on underlying medical conditions was available for all decedents (Table 4; Supplemental Figure 2); 96 decedents (86%) had at least one underlying medical condition, including 50 (52%) with 3 underlying medical conditions and 25 (26%) with 5 underlying medical conditions. The most commonly documented conditions were obesity (47, 42%), asthma or reactive airway disease (33, 29%), and developmental disorders (25, 22%). Thirteen decedents (12%) had an active malignancy, of which 8 (7%) were hematologic. Eighteen decedents (16%) were dependent on a gastrostomy tube for nutrition prior to illness onset. A higher proportion of decedents without MIS-C had at least one underlying condition (70/80, 87%) than decedents with MIS-C (11/16, 69%) (p = 0.06).

Among the 16 decedents with no underlying medical conditions, 12 (75%) were male. Eight (50%) were Hispanic, 5 (31%) were Black (non-Hispanic), 2 (13%) were White (non-Hispanic), and 1 (6%) was Hawaiian/Pacific Islander/Asian (non-Hispanic). These decedents were younger than decedents with underlying medical conditions (median age 2 years [IQR 0.75–12 years] vs median age 17 years [IQR 12–19 years], *p*<0.001). Five had MIS-C (31%) compared to 11/96 (11%, p=0.13) among all other decedents, and 11 (69%) died at home or in the emergency department compared to 30/96 (31%, p=0.02) among all other decedents. Four (25%) had been seen in an ambulatory or urgent care setting prior to death. The location of exposure to COVID-19 was available for 46 decedents (41%). The most common location for reported exposure was the decedent's household (33, 72%).

Data on reported symptoms were available for 67/80 (84%) decedents without MIS-C and 14/16 (88%) decedents with MIS-C (Supplementary Table 1). The most commonly reported symptoms for decedents without MIS-C were fever (44/67, 66%), dyspnea (36/67, 54%), cough (34/67, 51%), nausea/vomiting (18/67, 27%), and fatigue (17/67, 25%); the most commonly reported symptoms for decedents with MIS-C (besides fever, which is part of the case definition for MIS-C) were cough (10/14, 71%), nausea/vomiting (10/14, 71%), dyspnea (6/14, 43%), loss of appetite (6/14, 43%), dehydration (6/14, 43%), and nasal congestion (5/14, 36%).

Among 98 (88%) decedents with a recorded symptom onset date, the median illness duration (time from symptom onset to death) was 11 days (IQR 7–23 days). Among 99 decedents with a recorded SARS-CoV-2 viral detection test date, the median time from a first positive test to death was 8 days (IQR 3–20 days). Decedents with MIS-C had a similar illness duration as those without MIS-C (median 11 days [IQR 6–27 days] vs. median 11 days [IQR 7–23 days], respectively) and had a similar time from first positive SARS-CoV-2

test to death compared to those without MIS-C (median 7 days [IQR 3–24 days] vs. median 8 days [IQR 7–23 days], respectively).

Non-hospitalized decedents (41, 37%) had similar age, gender, and race distributions compared with hospitalized decedents (69, 63%) (Supplementary Table 2). Non-hospitalized decedents had a shorter illness duration than hospitalized decedents (non-hospitalized: median 7 days, IQR 1–12 days; hospitalized: median 13 days, IQR 9–27 days; *p*<0.0001).

Among the 69 hospitalized decedents, the median number of days from symptom onset to hospital admission was 4 (IQR 2–7 days) and the median number of days from initial hospitalization to death was 9 (IQR 4–9 days). Fifteen (22%) met MIS-C criteria, 44 (64%) did not meet MIS-C criteria, and MIS-C status was unknown for 10 (14%) decedents MIS-C status. Fifty-five (80%) were admitted to the intensive care unit (ICU) at a median of 0 days (IQR 0–1 day) after hospitalization; the median duration from ICU admission to death was 8 days (IQR 3–13 days).

Vital signs at the time of presentation were available for 53/69 decedents (77%) who died after hospitalization (Supplementary Table 3), including 37/44 (84%) without MIS-C, 13/15 (87%) with MIS-C, and 3/10 (30%) with unknown MIS-C status. The prevalence of fever, tachycardia, and tachypnea were similar between decedents with MIS-C and those without MIS-C.

Laboratory studies were available for 40/69 (58%) decedents who died after hospitalization (Supplementary Table 4). Common findings included thrombocytopenia (32/40, 80%), elevated procalcitonin (18/40, 45%), and elevated ferritin (21/40, 53%). Laboratory studies for decedents with MIS-C were similar to decedents without MIS-C. Among the 60 decedents who died after hospitalization with available information on hospital course and therapeutics, 45 were intubated and required mechanical ventilation (75%) and 8 received extracorporeal membrane oxygenation therapy (13%, Table 5). One-quarter of decedents (15) who died after hospitalization received immunomodulatory therapy, and 21 (35%) received remdesivir.

Information on complications was available for 62 (90%) hospitalized decedents. The most commonly reported complications were acute respiratory failure (51, 82%), shock (35, 56%), acute respiratory distress syndrome (31, 50%), sepsis (25, 40%), and acute renal failure (21, 34%) (Table 5).

Discussion

Deaths associated with SARS-CoV-2 among individuals <21 years of age during February–July 2020 occurred predominantly among older adolescents, males, Black (non-Hispanic) and Hispanic persons, and persons with underlying medical conditions. Persons >15 years of age constituted 58% of deaths in this study, while persons <1 year of age constituted only 7% of deaths, which contrasts with other studies that have shown the highest numbers of deaths in both infants and older adolescents.[9,11,25,26] The predominance of males among the decedents in this study is consistent with previous studies, which found male sex as a risk factor for more severe illness among both children and adults with COVID-19.[27]

The COVID-19 pandemic has amplified racial and ethnic disparities in health, with Black (non-Hispanic) and Hispanic adults having higher rates of hospitalization due to COVID-19 than White (non-Hispanic) adults[10,28,29] and Black (non-Hispanic) and Hispanic children and adolescents having increased risk of severe COVID-19 illness and MIS-C compared to White (non-Hispanic) children and adolescents.[30–32] The majority of decedents in this study were Black (non-Hispanic) or Hispanic, providing further evidence of these disparities. Improving the health outcomes of populations disproportionately affected will require focused and ongoing strategies to address historical and contemporary injustices, and to eliminate health and healthcare disparities.[33]

The proportion of decedents in this study with at least one underlying condition is much higher than in the general pediatric population.[34–37] Developmental disorders are more prevalent among White (non-Hispanic) children compare to other racial and ethnic groups[34], and obesity is more prevalent among Hispanic children than White (non-Hispanic) or Black (non-Hispanic) children.[35] Children and adolescents with multiple underlying medical conditions, including those with complex medical needs, are at increased risk for severe disease, hospitalization, and death from COVID-19.[9,11,38] Obesity and neurologic and developmental conditions were common in this study; prior studies show that children with obesity and children with intellectual disabilities and seizure disorders have increased risk of both requiring critical care[25,26] and death associated with COVID-19.[39,40]

Most reported exposures among decedents in this study occurred in the household, which is consistent with transmission studies conducted outside of the United States.[41] Notably, this study occurred during the first 6 months of the pandemic in the United States, when many students were enrolled in remote learning and stay-at-home orders were in place in some locations around the country.[42] While classrooms appear to be a low-risk setting for SARS-CoV-2 transmission[43–46], some studies have suggested an increased role for transmission in children and adolescents outside of the home as they have resumed other activities and stay-at-home orders are lifted in some jurisdictions.[47,48] However, returning to face-to-face instruction may increase the risk of infection with SARS-CoV-2 and death in this population as in-person contact increases the risk of SARS-CoV-2 transmission.

Only 14% of decedents in this study met MIS-C criteria. Non-MIS-C COVID-19 represents a much higher contribution to SARS-CoV-2-associated mortality in this age group. Among those with MIS-C, a higher proportion were previously healthy decedents compared with those without MIS-C, consistent with other studies.[9,12] However, it is important to note that MIS-C criteria at the time of this study included severe illness requiring hospitalization, which likely contributes to the high proportions of persons with MIS-C who died after hospitalization.

Acute respiratory failure, shock, and acute renal failure were relatively common complications among decedents (Table 5). A high proportion of decedents admitted to the hospital required mechanical ventilation. Immunomodulatory therapy was relatively common, even for decedents who did not have MIS-C, and remdesivir was administered to nearly one-third of hospitalized children. The use of immunomodulatory therapy in pediatric patients without MIS-C is not recommended in current guidelines.[49] These results provide

insight into treatment practices in severely ill children and adolescents in the early phase of the pandemic before updated recommendations were established and should not be taken as treatment recommendations.

Limitations

This study has at least six limitations. First, there was no comparison group of children and adolescents who survived COVID-19 in this study, so we are unable to describe risk factors for death. Second, in some cases, death may have been incidentally associated with SARS-CoV-2 infection. Causal inference is difficult in descriptive studies and it is not always possible to determine whether decedents died from COVID-19 or died of other causes with active SARS-CoV-2 infection. However, a recent report found that death certificates provide accurate data for COVID-19 mortality surveillance.[50] Third, complete medical records, including laboratory data, were not available for all decedents. Fourth, data were entered by multiple abstractors, which may introduce data entry inconsistencies. Fifth, we do not have data on the number of COVID-19 cases in each age group during this period and cannot calculate case fatality rates or perform age-adjustment. Finally, this case series was assembled during the first six months of the pandemic prior to the emergence of multiple novel variants of concern and rapid expansion of vaccination. The combination of new variants of concern and increased rates of vaccination is likely to result in different symptomatology, illness severity, and case fatality than described here.

Conclusions

In this case series of individuals <21 years of age with SARS-CoV-2-associated deaths, most decedents were older adolescents or young adults and members of racial/ethnic minority groups. Obesity, developmental disorders, and asthma were the most commonly reported underlying conditions. Persons <21 years of age with COVID-19 disease resulting in death frequently had underlying medical conditions, while decedents with MIS-C were more likely to have no underlying medical conditions than decedents who did not meet MIS-C criteria. Acute respiratory failure requiring mechanical ventilation, shock, and cardiac arrythmias were common complications during hospitalization. Pediatric providers who care for children with complex medical needs should continue to counsel families about the importance of preventive behaviors and the risk for severe COVID-19, as well as to seek medical attention early if they develop COVID-19-like symptoms. These children may be at increased risk of decompensation during hospitalization and should be monitored closely if admitted to the hospital. Vaccination is available for persons >11 years of age and vaccine uptake will be a critical intervention to prevent COVID-19 mortality in this age group.[51] Continued assessment of pediatric and adolescent deaths as the pandemic continues is critical to understanding disease and mortality in this population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Appendix

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Abbreviations:

BMI
Body mass index

CDC
US Centers for Disease Control and Prevention

COVID-19
coronavirus disease 2019

ESR
erythrocyte sedimentation rate

LDH
lactate dehydrogenase

ICU

intensive care unit

IQR

interquartile range

MIS-C

multisystem inflammatory syndrome in children

Research Electronic Data Capture

REDCap

RR

respiratory rate

SARS-CoV-2

severe acute respiratory system coronavirus 2

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What's Known on This Subject

Pediatric mortality from SARS-CoV-2 is uncommon. Previous studies have reported risk factors associated with severe COVID-19 disease and MIS-C, and case series from Europe and China have described clinical features of pediatric SARS-CoV-2-associated deaths.

What This Study Adds

SARS-CoV-2-associated deaths among persons <21 years of age during February–July 2020 occurred predominantly among older adolescent males and Black (non-Hispanic) and Hispanic persons. Obesity, asthma, and developmental disorders were the most commonly reported underlying conditions.
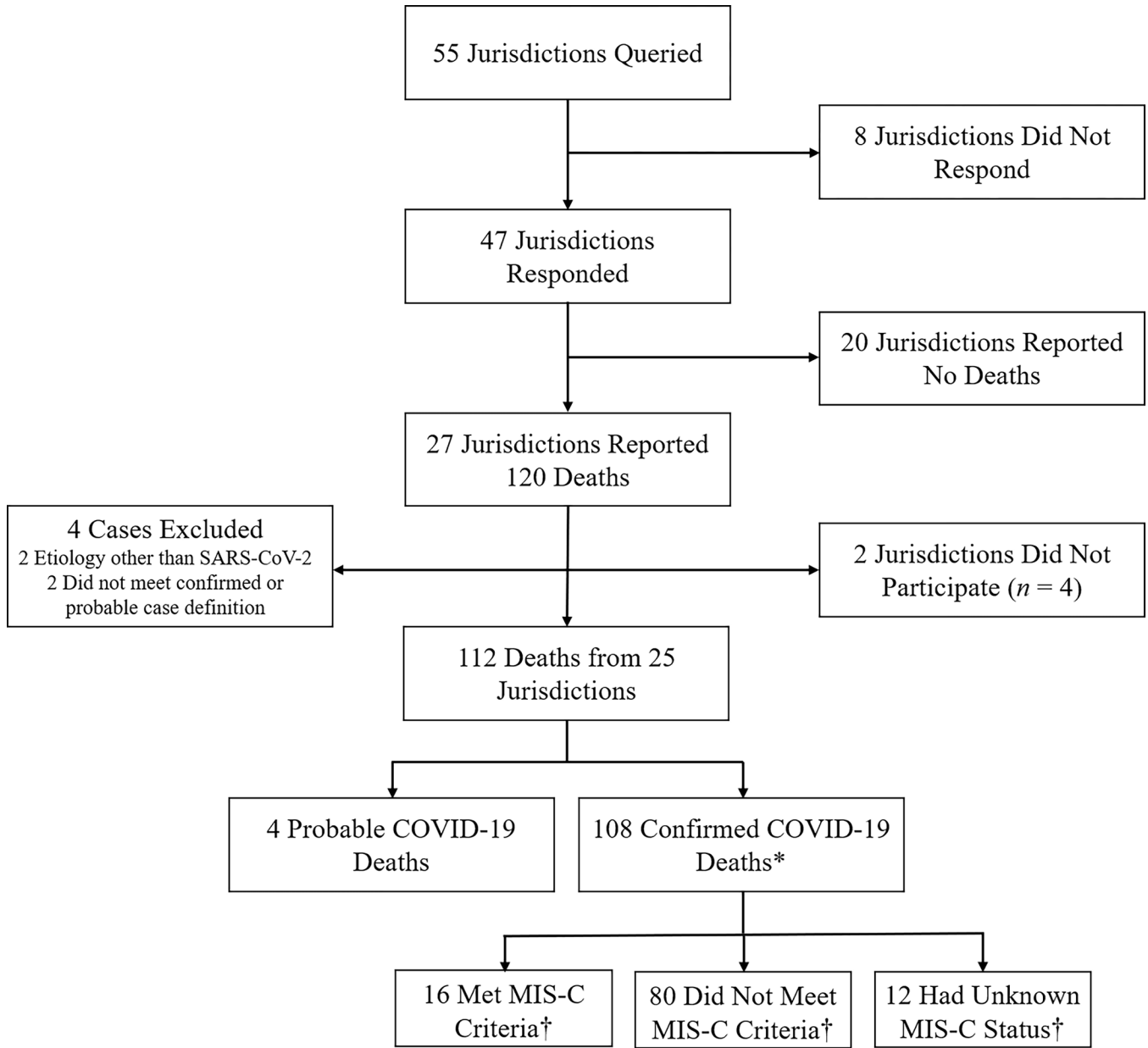
Figure 1.

Study flow diagram.

Abbreviation: MIS-C, Multisystem inflammatory syndrome in children

* The interim COVID-19 case definition published by the Council of State and Territorial Epidemiologists on August 5, 2020 was used to classify cases as confirmed or probable.[16]

†Cases met MIS-C criteria if they fulfilled the case definition published in the CDC Health Alert Network Health Advisory on May 14, 2020.[17]
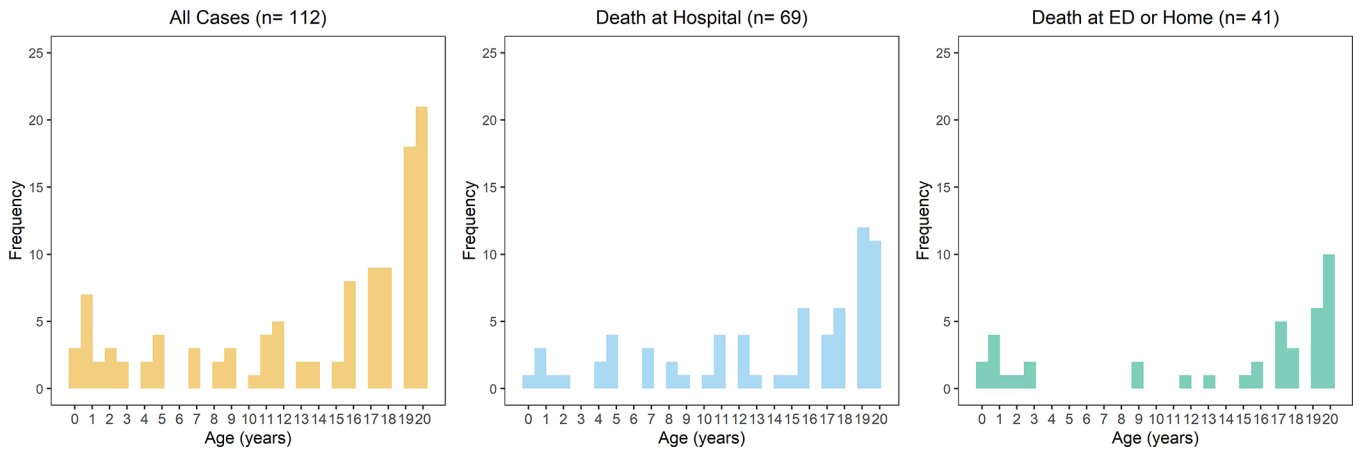
Figure 2.
Histogram showing the age distribution for all decedents (A), those who died in the hospital
(B), and those who died at home or in the emergency department (C).

Table 1.

Demographic characteristics of all decedents ($n = 112$)

	N	%
Gender		
Male	71	63
Female	41	37
Age in years (Median, Interquartile Range)	17, 8.5–19	
<1	8	7
1–4	11	10
5–9	12	11
10–13	12	11
14–17	21	19
18–20	48	43
Race/Ethnicity		
White (non-Hispanic)	16	14
Black, non-Hispanic	31	28
Hispanic	52	46
American Indian or Alaska Native (non-Hispanic)	5	5
Asian or Pacific Islander (non-Hispanic)	5	5
Other	2	2
Unknown	1	1
Geographic Region [*]		
Midwest	13	12
Northeast	35	31
South	41	37
West	23	21

[*] Regions based on US Census Bureau regions (https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf). US territories assigned to Census regions based on their geographic proximity to states assigned to those regions and based on their assignment to standard federal regions (https://www.gsa.gov/about-us/gsa-regions).

Table 2.

Demographic characteristics for decedents with known multisystem inflammatory syndrome in children (MIS-C) status ($n = 96$)

	Met MIS-C Criteria* ($n = 16$)		Did not Meet MIS-C Criteria ($n = 80$)	
	N	*%*	*N*	*%*
Gender				
Male	9	56	51	64
Female	7	44	29	36
Age in years (Median, Interquartile Range)	16, 6–19		17, 11–19	
<1	1	6	7	9
1–4	2	13	6	8
5–9	3	19	6	8
10–13	1	6	9	11
14–17	4	25	15	19
18–20	5	31	37	46
Race/Ethnicity				
White (non-Hispanic)	1	6	13	16
Black (non-Hispanic)	4	25	24	30
Hispanic	9	56	32	40
American Indian or Alaska Native (non-Hispanic)	0	0	5	6
Asian or Pacific Islander (non-Hispanic)	1	6	4	5
Other	1	6	1	1
Unknown	0	0	1	1
Geographic Region*†*				
Midwest	1	6	12	15
Northeast	3	19	26	33
South	9	56	23	29
West	3	19	19	24
Underlying Medical Conditions				
None (0)	5	31	10	13
Any (1)	11	69	70	87

*
Cases met MIS-C criteria if they fulfilled the case definition published in the CDC Health Alert Network Health Advisory on May 14, 2020.[17]

†
Regions based on US Census Bureau regions (https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf). US territories assigned to Census regions based on their geographic proximity to states assigned to those regions and based on their assignment to standard federal regions (https://www.gsa.gov/about-us/gsa-regions).

Table 3.

Disease classification and hospitalization status for decedents with clinical information ($n = 112$)

	N	%
COVID-19 Classification[*]		
Confirmed	108	96%
Probable	4	4%
MIS-C Classification[†]		
Met MIS-C Criteria	16	14%
Did not Meet MIS-C Criteria	80	71%
Unknown MIS-C Status	16	14%
Hospitalization Status		
Hospitalized	69	62%
Not Hospitalized	43	38%
Admitted to Intensive Care Unit[‡]		
Yes	55	49%
Unknown	14	10%
Not Applicable	47	42%
Outpatient Medical Visits Prior to Death[**]		
Emergency Department Visit Only	16	13%
Clinic or Urgent Care Visit Only	25	22%
Both Emergency Department and Clinic or Urgent Care Visit	4	4%
None	35	31%
Unknown	32	29%
Location of Death		
Hospital	69	62%
Emergency Department	23	21%
Home	18	16%
Hospice Care	1	1%
Unknown	1	1%
COVID-19 Contribution to Death		
Underlying	48	43%
Contributing Factor	21	19%
Unknown Death Certificate not Available	5	4%
Death Certificate not Available	38	34%

Abbreviation: MIS-C, Multisystem inflammatory syndrome in children

[*] The interim COVID-19 case definition published by the Council of State and Territorial Epidemiologists on August 5, 2020 was used to classify cases as confirmed or probable.[16]

[†] Cases met MIS-C criteria if they fulfilled the case definition published in the CDC Health Alert Network Health Advisory on May 14, 2020.[17]

[‡] Restricted to those patients who were admitted to the hospital

** Defined as seeking care in an emergency department, urgent care center, or outpatient clinic   1 day prior to death or hospitalization, whichever came first

Table 4.

Underlying medical conditions for all decedents, decedents who met MIS-C criteria, and decedents who did not meet MIS-C criteria ($n = 112$)

	All Decedents ($n = 112$)		Met MIS-C Criteria ($n = 16$)		Did not Meet MIS-C Criteria ($n = 80$)	
	N	*%*	*N*	*%*	*N*	*%*
Number of Underlying Medical Conditions						
None	16	14%	5	31%	10	13%
1	24	21%	1	6%	17	21%
2	22	20%	4	25%	15	19%
3	15	13%	2	13%	13	16%
4	10	9%	1	6%	8	10%
5	25	22%	3	19%	17	21%
Metabolic and Endocrine	**51**	**46%**	**7**	**44%**	**39**	**49%**
Obesity	47	42%	5	31%	37	46%
Diabetes Mellitus [*]	11	10%	1	6%	9	11%
Other[a]	12	11%	2	135	9	11%
Neurologic and Developmental	**37**	**33%**	**5**	**31%**	**24**	**30%**
Developmental Disorder	25	22%	3	19%	15	19%
Seizure disorder	17	15%	3	19%	11	14%
Other[b]	20	18%	2	13%	15	19%
Respiratory	**35**	**31%**	**6**	**38%**	**24**	**30%**
Asthma or Reactive Airway Disease	33	29%	5	31%	23	29%
Other[c]	6	5%	1	6%	2	3%
Cardiovascular	**20**	**18%**	**3**	**19%**	**14**	**18%**
Hypertension	10	9%	0	0%	9	11%
Congenital Heart Disease	6	5%	1	6%	4	5%
Cardiomyopathy	3	35%	1	6%	2	3%
Other[d]	8	7%	1	6%	5	6%
Gastrointestinal/Hepatic	**21**	**19%**	**4**	**25%**	**12**	**15%**
Dependent on gastric tube feedings	18	16%	4	25%	11	14%
Gastroesophageal Reflux	5	4%	0	0%	2	3%
Other[e]	5	4%	3	19%	2	3%
Malignancy	**13**	**12%**	**1**	**6%**	**8**	**10%**
Hematologic Malignancy	8	7%	0	0%	4	5%
Non-hematologic Malignancy	5	4%	1	6%	4	5%

	All Decedents (*n* = 112)		Met MIS-C Criteria (*n* = 16)		Did not Meet MIS-C Criteria (*n* = 80)	
	N	%	*N*	%	*N*	%
Immunologic	**12**	**11%**	**0**	**0%**	**10**	**13%**
Immunosuppressive Therapy	6	5%	0	0%	6	8%
Solid organ or Stem Cell Transplant Recipient	3	3%	0	0%	3	4%
Other[f]	7	6%	0	0%	5	6%
Genetic	**12**	**11%**	**2**	**13%**	**7**	**9%**
Chromosomal Abnormality[g]	5	4%	2	13%	2	3%
Other[h]	7	6%	0	0%	5	6%
Hematologic [i]	**8**	**7%**	**0**	**0%**	**6**	**8%**
Psychiatric [j]	**8**	**7%**	**1**	**6%**	**6**	**8%**
Substance Use [k]	**6**	**5%**	**0**	**0%**	**6**	**8%**
Renal [l]	**6**	**5%**	**0**	**0%**	**5**	**6%**
Dermatologic [m]	**5**	**4%**	**1**	**6%**	**3**	**4%**
Rheumatologic [n]	**3**	**3%**	**0**	**0%**	**3**	**4%**
Other	**13**	**12%**	**2**	**13%**	**9**	**11%**
Sleep Apnea	8	7%	1	6%	6	8%
Other[o]	6	5%	2	13%	3	4%

[*] Includes both Type 1 and Type 2

[a] Includes hypothyroidism (4), panhypopituitarism (1), diabetes insipidus (1), hypothalamic-pituitary axis dysfunction (1), adrenal insufficiency (1), osteoporosis (1), and Other/Unknown (4)

[b] Includes autism (5), blindness (3), microcephaly (2), Charcot-Marie-Tooth (2), chronic inflammatory demyelinating polyradiculoneuropathy (1), hearing loss (1), septo-optic dysplasia (1), migraine (1), ataxia telangiectasia (1), hydrocephalus (1), and Other/Unknown (2)

[c] Includes bronchopulmonary dysplasia (1), Interstitial Lung Disease (1), and Other/Unknown (2)

[d] Includes lipid disorder (5), Wolff-Parkinson-White (1), and Other/Unknown (9).

[e] Includes history of necrotizing enterocolitis (2), history of malrotation (1), celiac disease (1), dysphagia (1), and history of liver transplantation (1).

[f] Includes Graft vs Host Disease (1) and Other/Unknown (6).

[g] Includes trisomy 13 (2), trisomy 21 (1), and unspecified chromosomal deletion (2).

[h] Includes congenital muscular dystrophy (2), cobalamin C deficiency (1), metachromatic leukodystrophy (1), neurofibromatosis (1), Rett Syndrome (1), and overgrowth syndrome (1).

[i]Includes anemia (4), deep vein thrombosis (2), sickle cell anemia (1), recurrent thrombosis (1), clotting disorder NOS (1), and Other/Unknown (1).

[j]Includes anxiety (1), major depressive disorder (1), history of suicide attempt (1), and Other/Unknown (6).

[k]Includes cigarette smoking (1), vaping (1), and unspecified substance abuse or misuse (5).

[l]Includes end-stage renal disease (2), neurogenic bladder (1), renal cyst (1), renal hyperplasia (1), history of continuous renal replacement therapy during a prior hospitalization (1), and Other/Unknown (1).

[m]Includes eczema (5).

[n]Includes juvenile rheumatoid arthritis (1), CREST syndrome (1), and systemic lupus erythematosus (1).

[o]Includes glaucoma (1), cleft palate (1), Herpes Simplex 1 infection (1), congenital cytomegalovirus (1), malnutrition (1), and Other/Unknown (1).

Table 5.

Selected medical interventions and complications for all decedents admitted to the hospital, those admitted to the hospital who met MIS-C criteria, and those admitted to the hospital who did not meet MIS-C criteria

	All Decedents[*]		MIS-C (*n* = 14)		Not MIS-C[†]	
	N	*%*	*N*	*%*	*N*	*%*
Respiratory Support						
Non-invasive positive-pressure ventilation	16	27%	3	21%	11	27%
Endotracheal intubation and mechanical ventilation	45	75%	11	79%	29	71%
Extracorporeal membrane oxygenation therapy	8	13%	4	29%	4	10%
Medical Interventions and Therapeutics						
Anticoagulation	37	62%	9	64%	25	61%
Vasopressor and/or inotrope support	36	60%	8	57%	25	61%
Corticosteroids	28	45%	7	50%	22	54%
Remdesivir	21	35%	5	36%	12	29%
Azithromycin	22	37%	4	29%	17	41%
Cardiopulmonary resuscitation	19	32%	4	29%	14	34%
Convalescent plasma therapy	16	27%	6	43%	8	20%
Hydroxychloroquine	16	27%	4	29%	12	29%
Immune modulators (anakinra, canakinumab, tocilizumab)	15	25%	6	43%	6	15%
Complications During Hospital Course						
Acute respiratory failure	51	82%	8	57%	37	88%
Shock	35	56%	9	64%	22	52%
Acute Respiratory Distress Syndrome	31	50%	6	43%	22	52%
Sepsis	25	40%	5	36%	17	40%
Acute renal failure	21	34%	4	29%	15	36%
Cardiac arrhythmia	16	26%	5	36%	11	26%
Cerebrovascular accident	4	6%	3	21%	1	2%
Deep vein thrombosis or pulmonary embolism	4	6%	1	7%	3	7%
Acute liver failure	3	5%	1	7%	2	5%
Myocarditis	3	5%	2	14%	1	2%

[*] Sample size varied by category, with (*n* = 60) for both "Respiratory Support" and "Medical Interventions and Therapeutics", and (*n* = 62) for "Complications During Hospital Course"

[†] Sample size varied by category, with (*n* = 41) for both "Respiratory Support" and "Medical Interventions and Therapeutics", and (*n* = 42) for "Complications During Hospital Course"